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(54) Title: SYSTEM AND METHOD FOR IMPROVED RESOURCE MANAGEMENT IN AN INTEGRATED TELECOMMUNICATIONS NETWORK HAVING A PACKET-SWITCHED NETWORK PORTION AND A CIRCUIT-SWITCHED NETWORK PORTION

(57) Abstract: A system and method for providing improved resource management, e.g., bandwidth re-allocation, in an integrated telecommunications network (100) having a packet-switched network portion (e.g., a Voice-over-Internet Protocol (VoIP) network portion) (104) and a cellular network portion (114). When a parametric variable associated with the number of registrations of mobile stations in a Mobile Switching Center (MSC) (114A) passes a threshold test (206), the MSC sends a message (306) to its gateway (106A), the message including a level change parameter. Responsive thereto, the gateway re-registers in a gatekeeper (110) that is provided for managing a zone in the VoIP network. The gateway includes in its registration request (308) the level change parameter received from the MSC. The gatekeeper uses the level change parameter as an input to its resource management function and re-allocates the resources available for the gateway. In another aspect, the gatekeeper is aware of the mobile stations served by the MSC and the network address of the corresponding gateway because the mobile stations also register in the gatekeeper, with their Mobile Directory Numbers (MDNs) being provided to the gatekeeper via the gateway. Since the gatekeeper is aware of the mobile stations associated with a particular gateway, it can dynamically manage the resources allocated to the gateway. Additionally, when an in-coming call intended for the mobile station (116) is received in the VoIP network portion, the gatekeeper (110) routes the in-coming call to the mobile station using the network address of the gateway (106B) with which the serving MSC (114B) is associated. Accordingly, the need for establishing inter-MSC trunks using circuit-switched paths for routing in-coming calls in the integrated telecommunications network is thereby obviated.

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SYSTEM AND METHOD FOR IMPROVED RESOURCE MANAGEMENT IN AN INTEGRATED TELECOMMUNICATIONS NETWORK HAVING A PACKET-SWITCHED NETWORK PORTION AND A CIRCUIT-SWITCHED NETWORK PORTION

CROSS-REFERENCE TO RELATED APPLICATIONS

This application discloses subject matter related to the subject matter disclosed in the following co-assigned patent application: "System and Method for Mobile Terminal Registration in an Integrated Wireless Packet-Switched Network," filed October 26, 1999, Ser. No.09/427471(Attorney Docket Number 1000-154), in the names of: Hung Tran, Laura Hernandez, Jean-Francois Bertrand, and Bartosz Balazinski.

BACKGROUND OF THE INVENTION

Technical Field of the Invention

The present invention relates to integrated telecommunication systems and, more particularly, to a system and method for providing improved resource management (for example, bandwidth allocation) in an integrated telecommunications network having a packet-switched network portion (for example, a network using the Internet Protocol (IP)) and a circuit-switched network portion such as a wireless telephony network portion. The present application also relates to unique registration of wireless subscribers in an H.323-based PSN portion for allowing for improved resource management and call routing.

Description of Related Art

Coupled with the phenomenal growth in popularity of the Internet, there has been a tremendous interest in using packet-switched network (PSN) infrastructures (e.g., those based on IP addressing) as a replacement for the existing circuit-switched network (CSN) infrastructures used in today's telephony. From the network operators' perspective, the inherent traffic aggregation in packet-switched infrastructures allows for a reduction in the cost of transmission and the infrastructure cost per end-user. Ultimately, such cost reductions enable the network operators to

pass on the concomitant cost savings to the end-users.

Some of the market drivers that impel the existing Voice-over-IP (VoIP) technology are: improvements in the quality of IP telephony; the Internet phenomenon; emergence of standards; cost-effective price-points for advanced services via media-rich call management, et cetera. One of the emerging standards in this area is the well-known H.323 protocol, developed by the International Telecommunications Union (ITU) for multimedia communications over packet-based networks. Using the H.323 standard, devices such as personal computers can inter-operate seamlessly in a vast inter-network, sharing a mixture of audio, video, and data across all forms of packet-based network portions.

The H.323 standard defines four major types of components for forming an inter-operable network: terminals, gateways, gatekeepers and Multipoint Control Units (MCUs). In general, terminals, gateways and MCUs of an H.323-based network are referred to as "endpoints." Gateways are typically provided between networks (or network portions) that operate based on different standards or protocols. For example, one or more gateways may be provided between a packet-switched network portion and a circuit-switched network portion. Terminals are employed by end-users for accessing the network or portions thereof, for example, for placing or receiving a call, or for accessing multimedia content at a remote site.

The gatekeeper is typically defined as the entity on the network that provides address translation and controls access to the network for other H.323 components. Usually, a gatekeeper is provided with the address translation capability for a specified portion of the network called a "zone." Typically, a zone comprises all terminals, gateways, and MCUs (that is, all endpoints) managed by a single gatekeeper. Accordingly, a plurality of gatekeepers (sometimes referred to as a "gatekeeper cloud") may be provided for managing the entire network, each gatekeeper being responsible for a particular zone. In addition to address translation, gatekeepers may also provide other services to the terminals, gateways, and MCUs such as bandwidth management and gateway location.

Those of ordinary skill in the art should appreciate that resource management (e.g., bandwidth allocation) is a critical component of a gatekeeper's responsibilities.

As part of its bandwidth control and management, a gatekeeper may reject calls from a terminal due to bandwidth limitations. This condition may occur if the gatekeeper determines that there is not sufficient bandwidth available on the network to support the call. In order to manage the bandwidth requirements of its zone, the gatekeeper typically partitions the available bandwidth among the endpoints such as the gateways connected to other networks (e.g., one or more CSNs). For this purpose, the gatekeeper generally requires an estimate of the number of users that can originate or receive traffic through the gateways.

When a gateway is coupled to a fixed network's switch, the number of subscribers associated with that node is relatively constant over a period of time. However, for gateways connected to Mobile Switching Centers (MSCs) of a cellular network, the number of subscribers served by the MSCs can change relatively rapidly depending on many factors, including the mobility of the subscribers. For example, in some serving areas, the use of cellular phones may be highly correlated to the time of day. Or, in some instances the cellular use may be sporadic and "bursty" because of the occurrence of special events such as, for example, sporting events, et cetera.

Based on the foregoing, it is apparent that in order to efficiently allocate the resources of a VoIP network, there arises a need to inform the gatekeeper of the number of mobile subscribers registered at MSCs connected to the gateways, so that the gatekeeper may dynamically re-allocate the resources for such gateways.

In addition, although the current VoIP networks offer rudimentary location services, they are not adequate for the mobility management required of a wireless network. In part, this deficiency is due to the condition that the gatekeeper which provides for call routing services and the registration of other H.323 entities within the VoIP network is typically unaware of conventional telecommunications terminals. While this condition is not a problem for fixed wireline telephones in terms of providing savings in long distance charges (which is generally considered to be one of the most importance economic drives behind IP-based call routing), calls involving mobile subscribers may still require establishing long distance trunks from one Mobile Switching Center (MSC) to another for routing. This is so because, currently, the Mobile Directory Number (MDN) of a mobile station (MS) is tied physically with the

MSC and its gateway, and when the mobile station roams out of its home area and is served by a visited MSC (VMSC), the gatekeeper is unaware of the updated location information. Accordingly, when an in-coming call is received in the PSN portion towards the mobile station, the gatekeeper routes the call to the "old" GW which sends it to the MSC where the MS was previously located. From there, an inter-MSC trunk (typically a long distance call) is needed to route the in-coming call to the VMSC, thereby nullifying one of the main economic benefits of integrating a PSN in the first place.

To address the deficiency set forth above, a proprietary interface between the gatekeeper and the Home Location Register (HLR) may be used. However, it should be appreciated that such solutions are still unsatisfactory because of the complexity of the interface involved. Furthermore, such a solution is proprietary and accordingly, not readily conducive for universal acceptance in the marketplace. Also, the HLR-GK interface requires supporting of two different types of protocols (IP vs. Signaling System No. 7 protocols) and, because of additional signaling required between the HLR and GK during call setup, further delay is experienced.

The present patent application provides a solution that addresses these and other deficiencies and drawbacks of the current VoIP technologies as set forth above.

SUMMARY OF THE INVENTION

In one aspect, the present invention is directed to a resource allocation method for use in an integrated telecommunications network. The method begins by monitoring a use level at a gateway disposed between a packet-switched network (PSN) portion, e.g., a Voice-over-Internet Protocol (VoIP) portion, and a circuit-switched network (CSN) portion of the VoIP network. The use level at the gateway corresponds to the number of subscribers originating or receiving traffic through the gateway. Depending on the use level and if the use level varies in accordance with a pre-determined test, an indication is sent from the gateway to a gatekeeper associated with the PSN portion. Thereafter, the gatekeeper re-allocates the resources for the gateway based on the indication received from the gateway.

In another aspect, the present invention is directed to a method of managing

resources in an integrated telecommunications network which includes a VoIP network portion having a gatekeeper and a gateway. A Mobile Switching Center (MSC) is coupled to the gateway. The MSC serves one or more mobile stations located in a serving area associated therewith. The method commences by monitoring the number of registrations of the mobile stations in the MSC. A determination is made in the MSC to verify if a pre-determined threshold limit test associated with the number of registrations is met. If so, a message is sent from the MSC to the gateway which includes a level change parameter that indicates a level of use corresponding to the mobile stations served by the MSC. Responsive to the message received from the MSC, a re-registration request is sent from the gateway to the gatekeeper. Preferably, the re-registration request includes the level change parameter. Upon receiving the re-registration request from the gateway, the gatekeeper re-allocates the resources for the gateway based on the level change parameter.

In a further embodiment, the present invention is directed to a method of managing resources in an integrated telecommunications network by directly registering mobile stations in a gatekeeper. The network includes, in addition to the gatekeeper, a gateway and an MSC coupled thereto, wherein the MSC is provided for serving one or more mobile stations located in a serving area associated therewith. The network further includes a Home Location Register (HLR) for at least one of the mobile stations. Upon detecting the mobile station located in the serving area of the MSC, the mobile station is registered in the HLR. Subsequently, a first message is sent from the MSC to the gateway, the message including a Mobile Directory Number (MDN) associated with the mobile station. Responsive to the first message from the MSC, a registration request is sent from the gateway to the gatekeeper, wherein the registration request includes the MDN and a network address associated with the gateway. A registration confirm message is sent from the gatekeeper to the gateway, provided the gateway is successfully registered therein. Thereafter, the gatekeeper re-allocates the resources of the gateway based on the number of mobile stations registered in the gatekeeper.

In yet another aspect, the present invention is directed to an integrated telecommunications network that is optimized for dynamic re-allocation of network

resources. The integrated network comprises a PSN portion and a cellular network portion, with a gateway disposed therebetween. An MSC that serves one or more mobile stations is coupled to the gateway and forms a portion of a cellular network portion of the VoIP network. A gatekeeper is associated with the packet-switched network portion for managing a bandwidth resource allocated to the gateway.

The integrated network includes means for monitoring the number of registrations of the mobile stations in the MSC. Responsive to the monitoring means, the network further includes means for determining whether the number of registrations of the mobile stations in the MSC meets a threshold level test. If so, means are available for sending a message from the MSC to the gateway wherein the message includes a level change parameter that corresponds to a change in a use level associated with the number of registrations of mobile stations in the MSC. The network also includes means for forwarding the level change parameter from the gateway to the gatekeeper such that when the gatekeeper receives the level change parameter, it re-allocates the bandwidth resource of the gateway based thereupon.

In a still further aspect, the present invention is directed to a call routing method in an integrated telecommunications network formed from combining a wireless CSN portion and a VoIP network portion. The integrated telecommunications network comprises cellular and VoIP components as set forth above. The method begins by detecting, in the MSC, the mobile station located in the serving area of the MSC. Thereafter, a first Q.931 message is sent from the MSC to the gateway. The Q.931message includes a Mobile Directory Number (MDN) associated with the mobile station detected by the MSC. Responsive to the first Q.931 message from the MSC, a registration request is sent from the gateway to the gatekeeper, the registration request including the MDN and a network address associated with the gateway. Subsequently, a registration confirm message is sent from the gatekeeper to the gateway, if the gateway is successfully registered therein. Upon receiving in the VoIP network portion the in-coming call intended for the mobile station, the in-coming call is routed by the gatekeeper to the mobile station using the gateway's network address.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the present invention may be had by reference to the following Detailed Description when taken in conjunction with the accompanying drawings wherein:

FIG. 1 depicts a functional block diagram of an embodiment of an integrated telecommunications network with a wireless CSN portion and a PSN portion (e.g., a Voice-over-IP (VoIP) network) wherein the teachings of the present invention may be advantageously practiced;

FIG. 2 depicts a flow chart of an exemplary embodiment of a resource management method for use in an integrated telecommunications network in accordance with the teachings of the present invention;

FIG. 3 depicts a control message pathway for a resource management method in an integrated telecommunications network in accordance with the teachings of the present invention;

FIG. 4 depicts a flow chart for another exemplary embodiment of the resource management method of the present invention;

FIG. 5 depicts a functional block diagram of another embodiment of an integrated telecommunications network; and

FIGS. 6A and 6B depict control message pathways for registering and unregistering a mobile station in an H.323-based PSN portion of an integrated telecommunications network in accordance with the teachings of the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

In the drawings, like or similar elements are designated with identical reference numerals throughout the several views, and the various elements depicted are not necessarily drawn to scale. Referring now to FIG. 1, depicted therein is an integrated telecommunications network 100 which includes a PSN portion in the form of an H.323-based IP core (i.e., Voice-over-IP (VoIP) network) portion 104. In addition to one or more IP terminals, for example, Terminal-1 108A and Terminal-2 108B, a plurality of gateways (GWs) are provided for interconnecting the IP core

network portion 104 with one or more circuit-switched infrastructures. GW-1 106A is connected to a Mobile Switching Center (MSC-1) 114A which forms, in conjunction with conventional entities such as a Visitor Location Register (VLR) (not shown in FIG. 1), a serving system for a mobile station (MS) 116. In a similar fashion, GW-2 106B is coupled to MSC-2 114B and MSC-3 114C. Accordingly, it should be realized that in a presently preferred exemplary embodiment of the present invention, a gateway may be coupled to one or more MSCs of a cellular network portion.

In addition, the integrated telecommunications network 100 may preferably include a landline Public Switched Telephone Network (PSTN) 102 that is coupled to the IP core portion 104 via GW-3 106C. It should be readily understood that the IP core portion 104 with all the endpoints described hereinabove may be treated as a zone that is managed by a single gatekeeper (GK) 110, which may be disposed in a gatekeeper cloud 112 in some embodiments. Furthermore, it should be appreciated that while the gatekeeper 110 is provided to be logically separate from the endpoints, its physical implementation may coexist with a terminal, MCU (not shown), gateway, or other appropriate entity. In accordance with the teachings of the present invention, the MSCs contain means for keeping track of the number of mobile stations registered therewith. In a preferred exemplary embodiment, such tracking means comprises a counter whose value increases or decreases based on the number of registered mobile stations. In a further embodiment, the PSTN's switching center may also include counting means that keeps track of the total number of fixed subscribers, although it may not vary as rapidly as the number of mobile subscribers registering at MSCs.

As explained in the Background section of the present patent application, the GK 110 is provided to be responsible for managing the resources allocated for use by the endpoints in its zone. FIG. 2 depicts a flow chart of an exemplary embodiment of a resource management method provided in accordance with the teachings of the present invention. After a mobile station, for example, MS 116, is detected in the serving area of a serving system (as exemplified by MSC-1 114A), it is registered in the serving system (steps 202 and 204). Pursuant to the mobile station's registration in the serving system, monitoring means such as, for example, a counter or equivalent

means, provided therein is appropriately incremented or otherwise suitably updated (step 205). Subsequently, as provided in decision block 206, the MSC determines if the monitored value (e.g., the counter value) or a function derived therefrom is greater than or equal to a selected threshold value. If the threshold value is not exceeded or met, the flow of the resource management method stops (step 208).

On the other hand, if the MSC determines that the counter value (or a function thereof) meets an appropriate threshold value test, it sends a message to the gateway (GW-1 106A) with which it is associated (step 210). Preferably, the message from the MSC comprises a Q.931 message which includes a level information parameter that is related to the number of the registered mobile stations served by the MSC. It should be readily appreciated by those of ordinary skill in the art that the number of registered mobile stations in the MSC at any time provides an indication of how much demand is exerted on the network resources at the gateway level. For example, if there is an increase in the number of mobile stations to be served by the MSC, the bandwidth allocated to the gateway to which the MSC is coupled may have to be appropriately incremented. Further, the level information parameter may vary depending upon a variety of factors such as, for example, the time of day, special events like sports, concerts, carnivals, et cetera, and, therefore, the bandwidth demand may also vary according to these factors. In an exemplary embodiment, the level information parameter may comprise a discrete stepwise function wherein different levels are associated with the step increments in the number of registered mobile stations. For instance, the level information parameter may be implemented as a *Level X* parameter such that whenever the number of registered mobile stations (denoted by N) crosses selected bands, levels, thresholds, or steps, the value of *X* changes accordingly. Thus, *Level 1* may be associated with the condition $N \leq 4999$; *Level 2* may be associated with the condition $5000 \leq N \leq 9999$; *Level 3* may be associated with the condition $10000 \leq N \leq 14999$, et cetera. In this exemplary embodiment, therefore, the MSC sends a Q.931 message to the gateway when the 5000th mobile subscriber and 10000th mobile subscriber register in the serving system. Further, in order to avoid oscillating registrations around the level boundaries within a pre-determined amount of time (e.g., within a minute), the MSC may preferably implement minimum time

intervals between sending the Q.931 messages. Alternatively, the MSC may implement a "one-sided guard band" at the level boundaries so that once a message is sent at the boundary, the next message is sent only when N falls below the guard band. For example, after sending the message at the registration of the 5000th mobile subscriber, the MSC sends a level information parameter again only when N drops by a pre-determined number, say 50. That is, the MSC sends the level information parameter when N = 4950.

It should be readily apparent to those of ordinary skill in the art upon reference hereto that numerous variations may be had with respect to the generation of messages containing the level information parameter provided in accordance with the teachings of the present invention. For example, different guard bands may be provided at different level boundaries. Also, a combination scheme with appropriate pre-determined time intervals and guard bands may be used as well for triggering the messages to the gateway. Moreover, the actual value of N that triggers the message may also be included in the message, in addition to the *Level X* parameter.

Continuing to refer to FIG. 2, once the level information is received by the gateway, it re-registers with the gatekeeper of the zone by sending an appropriate H.323 *Registration Request* (*RRQ*) message (step 212). The *RRQ* message preferably contains the level information parameter and, optionally, the value of N as well. This information is provided as an input to the resource management function of the gatekeeper. Based on the level information, the gatekeeper subsequently re-allocates the resources (e.g., bandwidth) for the zone (step 214) which includes the MSC for supporting mobile subscribers.

Referring now to FIG. 3, depicted therein is a control message pathway associated with the resource management method described hereinabove. Upon receiving a suitable registration request message 302 from the MS 116, MSC-1 114A responds by sending an appropriate return result message 304 to the MS 116. Pursuant to the registration request message 302, MSC-1 114A sends a Q.931 message 306 to the gateway, GW-1 106A, if suitably triggered as set forth above. The Q.931 message 306 may comprise any one of the following *MISCELLANEOUS* Q.931 messages: *REGISTER, FACILITY,* or *INFORMATION*, with the *Call Reference*

Information element set to a *DUMMY* call. Whereas the *INFORMATION* message is related to the Feature Key Management protocol, the *FACILITY* message is used for the Functional protocol. One of ordinary skill in the art should appreciate that the *FACILITY* or *REGISTER* message is preferable, as these messages separate the registration activity from the actual call control with which the *INFORMATION* message is associated.

The *Facility Information* element in the Q.931 message 306 indicates to GW-1 106A that the message 306 pertains to a registration activity with respect to a change in the number of registered mobile subscribers served by MSC-1 114A (that is, the *LEVEL* parameter) and, optionally, the value of N. It should be understood that the message 306 may, in an alternative embodiment, comprise a suitable Integrated Services Digital Network (ISDN) User Part (ISUP) message also.

In addition to the exemplary embodiments of the message triggering process described in particular reference to FIG. 2 above, the sending of the message 306 from MSC-1 114A to GW-1 106A may also be done at pre-determined time intervals. Also, the sending of the message 306 may correspond to the gateway's *timetoLive* parameter which is sent from the zone's gatekeeper 110 to GW-1 106A at the time of its initial registration with the gatekeeper.

Continuing to refer to FIG. 3, responsive to the message 306 from MSC-1 114A, GW-1 106A sends an H.323 *RRQ* message 308, including the *LEVEL* parameter, for re-registering with the GK 110. The GK 110 uses the parametric information received from GW-1 106A as input to its resource management function and re-allocates an appropriate amount of bandwidth for the gateway. Upon successful re-registration of GW-1 106A in the GK 110, a *Registration Confirm* (*RCF*) message 310 is returned therefrom. Thereafter, a suitable Q.931 answer 312 may be provided by GW-1 106A to MSC-1 114A.

As is well-known in the art, a gateway disposed in a VoIP network may be coupled to more than one MSC. For example, such a scenario is exemplified in FIG. 1 wherein GW-2 106B is associated with two MSCs, MSC-2 114B and MSC-3 114C. Accordingly, each MSC may have its own level information parameter that is sent via a Q.931 message to the gateway independent of the other MSC's level information

and message triggering. In such a case, the gateway itself may be provided with a level information parameter that is functionally related to the MSCs' levels. Preferably, the gateway may re-register with the zone's gatekeeper only when its level information parameter, whose value is contingent upon the messages from the MSCs, meets a suitable threshold test.

Referring now to FIG. 4, a flow chart is shown therein for a resource management method for use with a gateway having multiple MSCs. It should be readily apparent that the steps depicted in the flow chart are essentially the same as the steps described in greater detail hereinabove with respect to FIG. 2. Accordingly, only the salient features of this exemplary embodiment are set forth herein. When the two serving systems (as exemplified by MSC-2 114B and MSC-3 114C) determine that their respective threshold limit tests are met by the level information parameters, they send their respective parameters via suitable Q.931 messages (steps 408A and 408B) (which messages may be independently triggered) to GW-2 106B. In accordance with the teachings of the present invention, the GW is provided with the capability to update its own level parameter or the actual value of the total number of registered subscribers associated with the gateway node based on the received level parameters and, optionally, the respective values of N. After a suitable update calculation (step 412), a determination is made if the result meets the GW's triggering test (decision block 414). If so, the GW re-registers with the GK 110 for the purpose of providing the demand level information as an input to the GK's resource management function (step 418). Thereafter, the GK re-allocates appropriate resources (e.g., bandwidth) for the GW as described above.

Based upon the foregoing, it should be appreciated by those of ordinary skill in the art that a gatekeeper disposed in a zone is capable of dynamically re-allocating the network's resources when it is aware of the variable load, i.e., the total number of registered mobile subscribers associated with the gateway nodes in the zone. It should be further appreciated that gateways that re-register in the gatekeeper typically indicate only intermittently to the gatekeeper as to what the level changes may be. In another aspect of the present invention set forth below, the gatekeeper may be provided with the capability to be aware of the load in a more direct way by registering the mobile

stations themselves. Furthermore, as will be described in greater detail hereinbelow, this alternative aspect of the present invention gives rise to the additional advantage of obviating the need for establishing inter-MSC trunks over circuit-switched portions for long distance calls.

FIG. 5 depicts a functional block diagram of another embodiment of an integrated telecommunications network 500 that is substantially similar to the network 100 described hereinabove. As is well-known in the art, the existing implementations of a VoIP network do not account for the mobility of the subscribers because there are no procedures available for registering a non-H.323 endpoint (for example, the MS 116) at the gatekeeper 110. Instead, the Mobile Directory Number (MDN) of an MS is typically tied physically with an MSC and the GW associated therewith. While a Home Location Register (HLR) 504 may be provided for handling mobility via a proprietary interface 506 between the HLR and GK 110, it should be appreciated that the interface 506 may be complex (because of the differences between the protocols involved) and may add to delays at call setup (because of additional signaling).

Currently, the GK analyzes the MDN of an MS and maps it to the GW corresponding to the MSC that serves the MS. For example, when the MS 116 is served by its home MSC, MSC-1 114A, its MDN is mapped to GW-1 106A. Thereafter, if the MS 116 roams into a visited area served by MSC-2 114B, the GK 110 is generally unaware of the MS's new location unless it is capable of querying the HLR 504 via the interface 506. If the GK 110 does not know the current location of the MS 116, a circuit-switched trunk 508 from MSC-1 to MSC-2 is required in order to route an in-coming call received at O-GW 502. Moreover, the inter-MSC trunk is established after the home MSC (MSC-1 114A) queries the HLR 504, thereby giving rise to further setup delay.

In addition, it should be readily appreciated by those of ordinary skill in the art that the requirement of establishing inter-MSC trunks for routing calls as set forth above nullifies one of the main economic benefits of integrating a PSN with a CSN in the first place, namely, the savings in long distance charges. For example, the inter-MSC call leg may be a long distance call which can be between two neighboring regions such as Local Access and Transport Areas (LATAs), two LATAs

geographically separated from each other, or across a continent. Clearly, routing such long distance call segments over CSN portions (for inter-MSC trunks) defeats the rationale behind the use of VoIP networks in integrated telecommunications networks having CSN portions.

FIGS. 6A and 6B depict control message pathways for registering and unregistering a mobile station in an integrated telecommunications network having a VoIP network portion and a wireless CSN portion, in accordance with the teachings of the present invention. Preferably, the MSC registers the mobile stations in the GK via the GW associated therewith. Furthermore, the same trigger criteria used for registering or unregistering the mobile stations with the HLR may be advantageously employed herein.

Using the HLR's registration criteria 602 for the MS 116, MSC-1 114A sends a Q.931 *MISCELLANEOUS* message 604 to GW-1 106A which includes the *MDN* and *Registration* parameters. Also, the *Call Reference Information* element of the message 604 is set as a *DUMMY* call. Any of the Q.931 *MISCELLANEOUS* messages, e.g., *INFORMATION* or *FACILITY*, may be used for the purposes of the present invention, although it should be appreciated by those of ordinary skill in the art that the *FACILITY* message is preferable. The MDN of the MS 116 is preferably sent in the message as the *Calling Party Number*. Responsive to the Q.931 message 604, GW-1 106A sends an *RRQ* message 606 to the GK 110 which contains the IP address of the GW and an *Alias* address that is the same as the *MDN*. Upon receiving the parametric information, the GK 110 adds the *Alias* address to the existing *Alias* addresses (which belong to other MSs registered in the GK) associated with the network IP address of the GW. Thereafter, the GK 110 sends an *RCF* message 608 to GW-1 106A.

FIG. 6B depicts the control message pathway for unregistering (i.e., canceling a registration) a mobile station in a VoIP network portion of an integrated network in accordance with the teachings of the present invention. Again, the trigger criteria used for canceling an HLR registration may also be used for canceling a mobile station's registration in the GK 110. Using the HLR's registration cancellation criteria 650 for the MS 116, MSC-1 114A sends a Q.931 *MISCELLANEOUS* message 652 to GW-1

106A which includes the *MDN* and *Registration* parameters. Responsive to the message 652, GW-1 106A sends an *Unregistration Request* (*URQ*) message 654 to the GK 110 including the parametric information as described above. Thereafter, the GK 110 responds by returning a *Unregistration Confirm* (*UCF*) message 656 to GW-1 106A.

Based on the foregoing, it should be readily appreciated that with the ability of registering mobile stations in the GK 110, any call intended for the MS 116 that is received at O-GW 502 can be routed therefrom to the serving system, e.g., 114B, without (i) first routing the call to GW-1; (ii) determining the address of GW-2 associated with the serving MSC-2; (iii) determining a Temporary Location Directory Number (TLDN) for MSC-2; (iv) providing the TLDN information to MSC-1; and (v) establishing an inter-MSC trunk from to MSC-2. Instead, the in-coming call is routed via: (i) directly routing the call to GW-2 using IP "backbone" and (ii) after media conversion, as appropriate, sending the voice traffic to the serving MSC-2 for call termination with the MS. Accordingly, as the call routing is effectuated utilizing the PSN portion rather than the CSN trunks, savings on the long distance charges are reliably realized.

Furthermore, because the GK 110 is aware of the registrations and unregistrations of mobile stations associated with different gateways in its zone, it can dynamically re-allocate bandwidth resources among them on an "as-needed" basis, in a similar fashion as described hereinabove.

In addition to the foregoing, the merits of the provision of MS registration with a H.323 network portion can be summarized as follows:

1. The gatekeeper is aware of the actual GW in which the MS is roaming/located when there is an in-coming call towards the MS;
2. More concrete definition of a relationship between gateways and MSCs. For certain embodiments of a VoIP network, a one-to-one relationship between the GW and the MSC is provided. That is, each GW is connected to a separate MSC;
3. The Q.931 message between the MSC and GW can be carried on the D-channel on any T1 or E1 trunk; and

4. The gatekeeper supports mobility and hence sets up the call between two GWs more efficiently. That is, the call is not routed to the GW attached to the MSC that corresponds to the MDN; rather, it is routed to the GW attached to the MSC where the MS is actually located.

Based on the foregoing Detailed Description, it should now be apparent that the present invention advantageously provides an efficient resource management and call routing solution for use in an integrated telecommunications network having a VoIP network portion and a CSN portion, thereby avoiding the problem of over-dimensioning the zone resources allocated for gateways with MSCs. The "adaptive" resource allocation method described herein is advantageous in mobile environments as well as networks with fixed subscribers. Moreover, the adaptive solution is very customizable because numerous trigger criteria may be used for sending the demand level change information to the gatekeeper of the zone. Not only can a VoIP network re-allocate the bandwidth resources at triggered time intervals, but a periodic re-allocation scheme (e.g., hourly, daily, or other circadian/diurnal periodicity) may also be implemented in some embodiments. When provided to be operable with pre-determined time-based triggers, the resource allocation method of the present invention may be advantageously implemented using the gateway's internal parameters such as, for example, the *timetoLive* parameter, which are sent from the gatekeeper to the gateway at its initial registration.

Further, it is believed that the operation and construction of the present invention will be apparent from the foregoing Detailed Description. While the method and system shown and described have been characterized as being preferred, it should be readily understood that various changes and modifications could be made therein without departing from the scope of the present invention as set forth in the following claims.

WHAT IS CLAIMED IS:

1. A resource allocation method for use in an integrated telecommunications network having a packet-switched network (PSN) portion and a circuit-switched network (CSN) portion, the method comprising the steps of:

monitoring a use level at a gateway disposed between the PSN portion and the CSN portion of the integrated telecommunications network, wherein the use level corresponds to the number of subscribers originating or receiving traffic through the gateway;

sending an indication, based on the use level, from the gateway to a gatekeeper associated with the PSN portion; and

re-allocating, by the gatekeeper, the resources for the gateway based on the indication received therefrom.

2. The resource allocation method as set forth in claim 1, further comprising the steps of:

monitoring the number of subscribers registered in a switching center coupled to the gateway; and

sending a message from the switching center to the gateway, the message including a parameter associated with the number of registered subscribers.

3. The resource allocation method as set forth in claim 2, wherein the message from the switching center to the gateway is sent periodically.

4. The resource allocation method as set forth in claim 2, wherein the message from the switching center to the gateway is sent based on the time of day.

5. The resource allocation method as set forth in claim 2, wherein the message from the switching center to the gateway is sent provided the number of registered subscribers meets a pre-determined threshold limit.

6. A method of managing resources in an integrated telecommunications network having wireless circuit-switched network (CSN) portion and a Voice-over-Internet Protocol (VoIP) network portion, the integrated network including a gatekeeper, a gateway disposed between the CSN and VoIP portions, and a Mobile Switching Center (MSC) coupled to the gateway, the MSC serving one or more mobile stations located in a serving area associated therewith, the method comprising the steps of:

monitoring the number of registrations of the mobile stations in the MSC;

determining, in the MSC, if the number of registrations meets a pre-determined threshold limit test;

if so, sending a message from the MSC to the gateway, the message including a level change parameter to indicate a level of use corresponding to the mobile stations served by the MSC;

responsive to the message received from the MSC, sending a re-registration request from the gateway to the gatekeeper, the re-registration request including the level change parameter; and

re-allocating the resources for the gateway by the gatekeeper based on the level change parameter.

7. The method of managing resources in an integrated telecommunications network as set forth in claim 6, wherein the message from the MSC to the gateway further includes the number of registrations of the mobile stations served by the MSC.

8. The method of managing resources in an integrated telecommunications network as set forth in claim 7, wherein the re-registration request from the gateway to the gatekeeper method further includes the number of registrations of the mobile stations served by the MSC.

9. The method of managing resources in an integrated

telecommunications network as set forth in claim 6, wherein the determining step is performed each time a mobile station is registered in the MSC.

10. The method of managing resources in an integrated telecommunications network as set forth in claim 6, wherein the message from the MSC to the gateway is sent periodically.

11. The method of managing resources in an integrated telecommunications network as set forth in claim 6, wherein the message from the MSC to the gateway is sent based on the time of day.

12. The method of managing resources in an integrated telecommunications network as set forth in claim 6, wherein the message from the MSC to the gateway comprises an Integrated Services Digital Network (ISDN) User Part (ISUP) message.

13. The method of managing resources in an integrated telecommunications network as set forth in claim 6, wherein the message from the MSC to the gateway comprises a Q.931 message.

14. The method of managing resources in an integrated telecommunications network as set forth in claim 13, wherein the Q.931 message from the MSC to the gateway comprises a Register message.

15. The method of managing resources in an integrated telecommunications network as set forth in claim 13, wherein the Q.931 message from the MSC to the gateway comprises a Facility message.

16. The method of managing resources in an integrated telecommunications network as set forth in claim 13, wherein the Q.931 message from the MSC to the gateway comprises an Information message.

17. A method for use in an integrated telecommunications network with a wireless circuit-switched network (CSN) portion and a Voice-over-Internet Protocol (VoIP) network portion, the integrated telecommunications network having a gatekeeper, a gateway disposed between the CSN and VoIP portions, and a Mobile Switching Center (MSC) coupled to the gateway, the MSC serving one or more mobile stations located in a serving area associated therewith, the wireless CSN portion including a Home Location Register (HLR) for at least one of the mobile stations, the method comprising the steps of:

detecting, in the MSC, the mobile station located in the serving area of the MSC;

sending a first message from the MSC to the gateway, the message including a Mobile Directory Number (MDN) associated with the mobile station detected by the MSC;

responsive to the first message from the MSC, sending a registration request from the gateway to the gatekeeper, the registration request including the MDN and a network address associated with the gateway;

sending a registration confirm message from the gatekeeper to the gateway, if the gateway is successfully registered therein; and

thereafter, re-allocating, by the gatekeeper, the resources of the gateway based on the number of mobile stations registered in the gatekeeper.

18. The method for use in an integrated telecommunications network as set forth in claim 17, further including the steps of:

determining, in the MSC, if the mobile station is no longer active in the serving area;

responsive to the determining step, sending a second message from the MSC to the gateway, the second message including the MDN of the mobile station;

responsive to the second message from the MSC, sending an unregistration request from the gateway to the gatekeeper, the unregistration request including the MDN and the network address of the gateway; and

sending an unregistration confirm return message from the gatekeeper to the gateway, if the gateway is successfully unregistered in the gatekeeper.

19. The method for use in an integrated telecommunications network as set forth in claim 17, wherein the first message from the MSC to the gateway comprises a Q.931 message.

20. The method for use in an integrated telecommunications network as set forth in claim 19, wherein the Q.931 message from the MSC to the gateway comprises a Facility message.

21. The method for use in an integrated telecommunications network as set forth in claim 19, wherein the Q.931 message from the MSC to the gateway comprises an Information message.

22. An integrated telecommunications network, comprising:

a Mobile Switching Center (MSC) serving one or more mobile stations, the MSC forming a portion of a cellular network portion of the integrated telecommunications network;

a gateway coupled to the MSC, the gateway being disposed between the cellular network portion and a packet-switched network portion of the integrated telecommunications network;

a gatekeeper associated with the packet-switched network portion, the gatekeeper managing a bandwidth resource allocated to the gateway;

means for monitoring the number of registrations of the mobile stations in the MSC;

means for determining whether the number of registrations of the mobile stations in the MSC meets a threshold level test;

means for sending a message from the MSC to the gateway, the message including a level change parameter which corresponds to a change in a use level associated with the number of registrations of mobile stations in the MSC; and

means for forwarding the level change parameter from the gateway to the gatekeeper, wherein the gatekeeper re-allocates the bandwidth resource of the gateway upon receiving the level change parameter.

23. A method of routing an in-coming call in an integrated telecommunications network with a wireless circuit-switched network (CSN) portion and a Voice-over-Internet Protocol (VoIP) network portion, the integrated telecommunications network having a gatekeeper, a gateway disposed between the CSN and VoIP portions, and a Mobile Switching Center (MSC) coupled to the gateway, the MSC serving one or more mobile stations located in a serving area associated therewith, the wireless CSN portion including a Home Location Register (HLR) for at least one of the mobile stations, the method comprising the steps of:

detecting, in the MSC, the mobile station located in the serving area of the MSC;

sending a first Q.931 message from the MSC to the gateway, the message including a Mobile Directory Number (MDN) associated with the mobile station detected by the MSC;

responsive to the first Q.931 message from the MSC, sending a registration request from the gateway to the gatekeeper, the registration request including the MDN and a network address associated with the gateway;

sending a registration confirm message from the gatekeeper to the gateway, if the gateway is successfully registered therein; and

thereafter, upon receiving in the VoIP network portion the in-coming call intended for the mobile station, routing the in-coming call by the gatekeeper to the mobile station using the gateway's network address.

24. The method of routing an in-coming call in an integrated telecommunications network as set forth in claim 23, further including the steps of:

determining, in the MSC, if the mobile station is no longer active in the serving area;

responsive to the determining step, canceling the mobile station's

registration in the HLR;

thereafter, sending a second Q.931 message from the MSC to the gateway, the second Q.931 message including the MDN of the mobile station;

responsive to the second Q.931 message from the MSC, sending an unregistration request from the gateway to the gatekeeper, the unregistration request including the MDN and the network address of the gateway; and

sending an unregistration confirm return message from the gatekeeper to the gateway, if the gateway is successfully unregistered in the gatekeeper.

25. The method of routing an in-coming call in an integrated telecommunications network as set forth in claim 23, wherein the Q.931 message from the MSC to the gateway comprises a Facility message.

26. The method of routing an in-coming call in an integrated telecommunications network as set forth in claim 23, wherein the Q.931 message from the MSC to the gateway comprises an Information message.

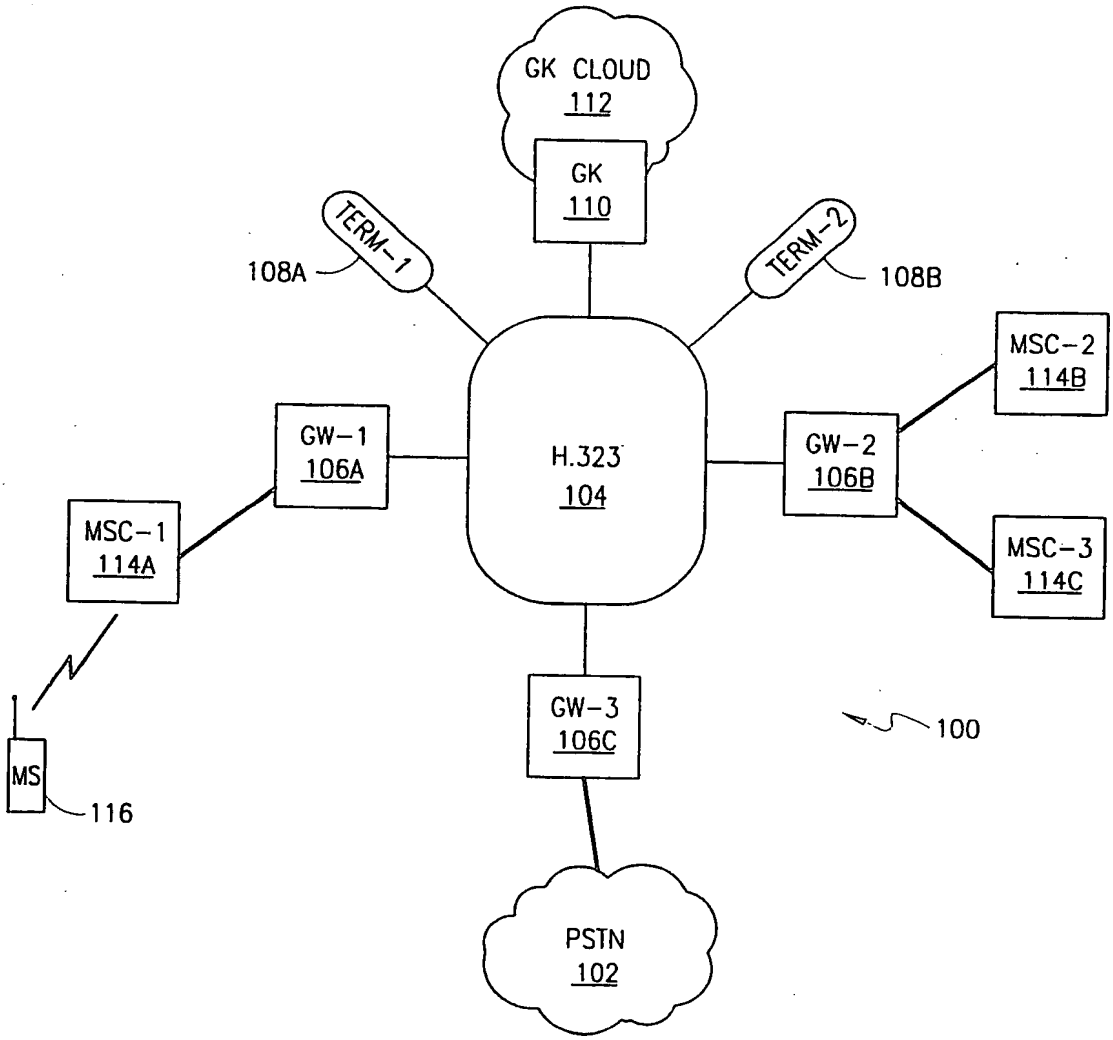
GK CLOUD
112
GK
110
TERM-1
108A
TERM-2
108B
MSC-2
114B
GW-1
106A
H.323
104
GW-2
106B
MSC-1
114A
MSC-3
114C
GW-3
106C
100
MS
116
PSTN
102

FIG. 1

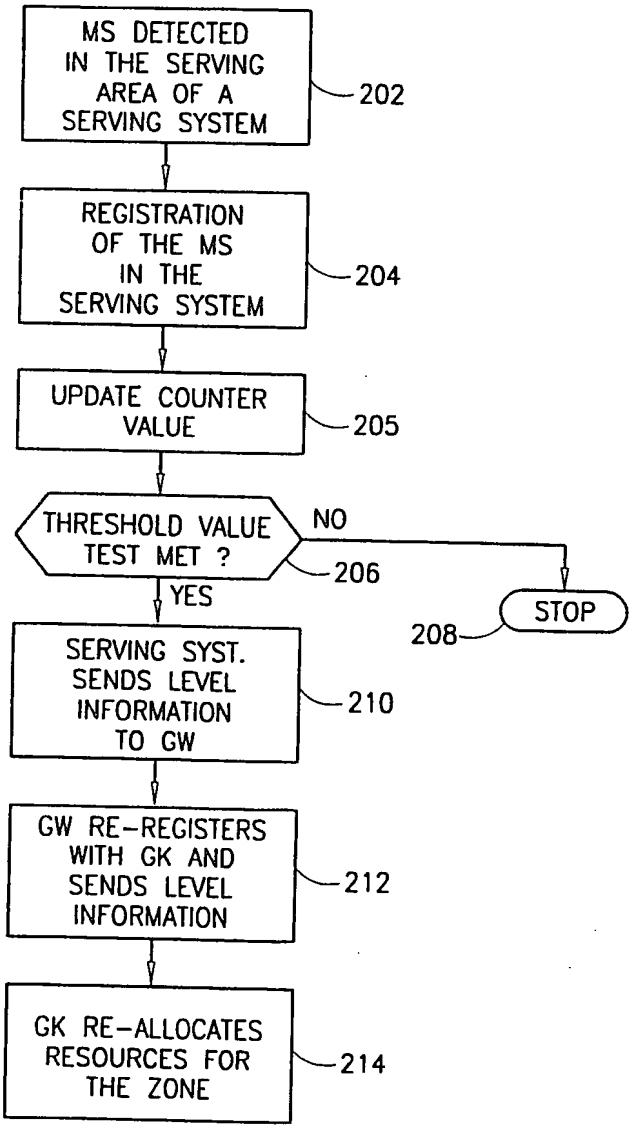

FIG. 2

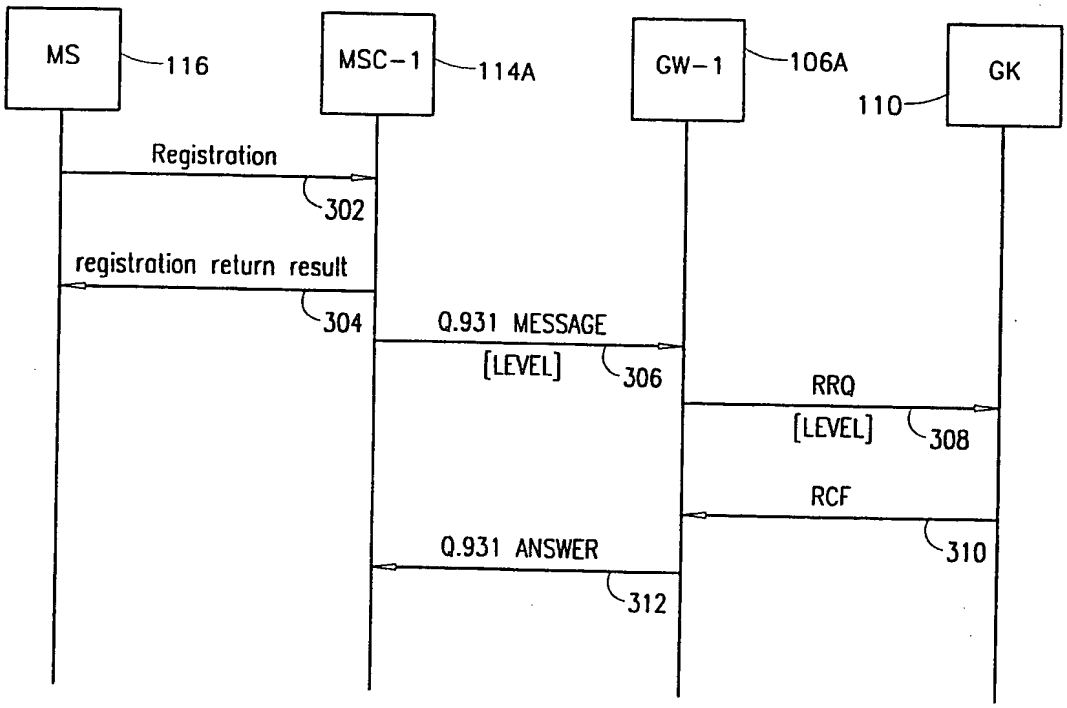
MS
116
MSC-1
114A
GW-1
106A
GK
110
Registration
302
registration return result
304
Q.931 MESSAGE
[LEVEL]
306
RRQ
[LEVEL]
308
RCF
310
Q.931 ANSWER
312

FIG. 3

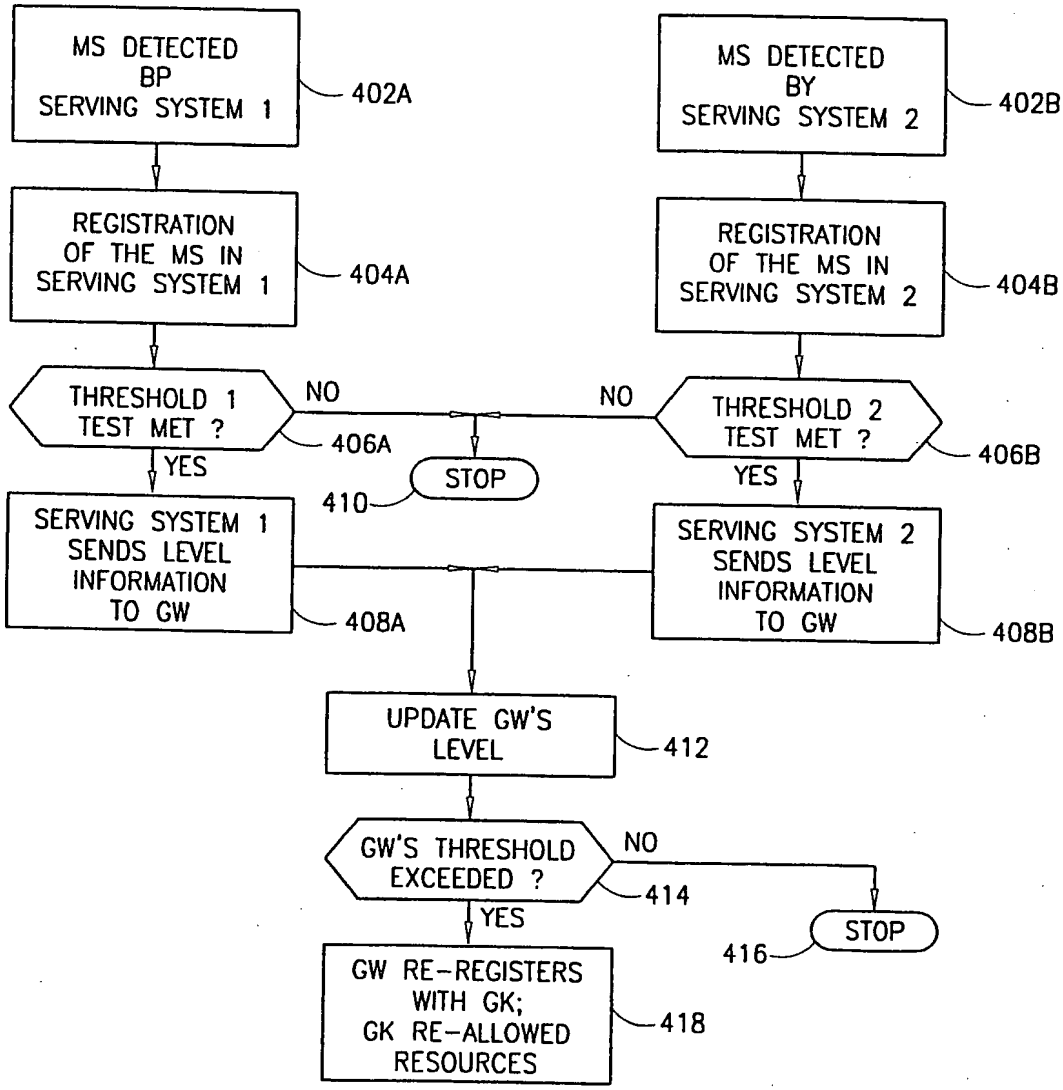

FIG. 4

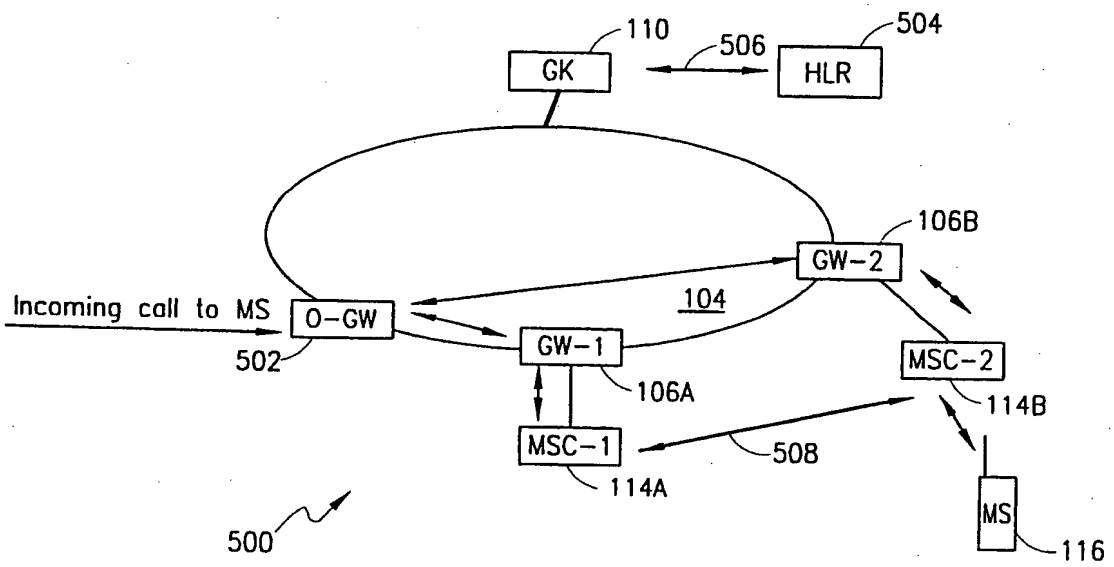
110
506
504
GK
HLR
106B
GW-2
Incoming call to MS
O-GW
104
GW-1
MSC-2
502
106A
114B
MSC-1
508
114A
MS
500
116

FIG. 5

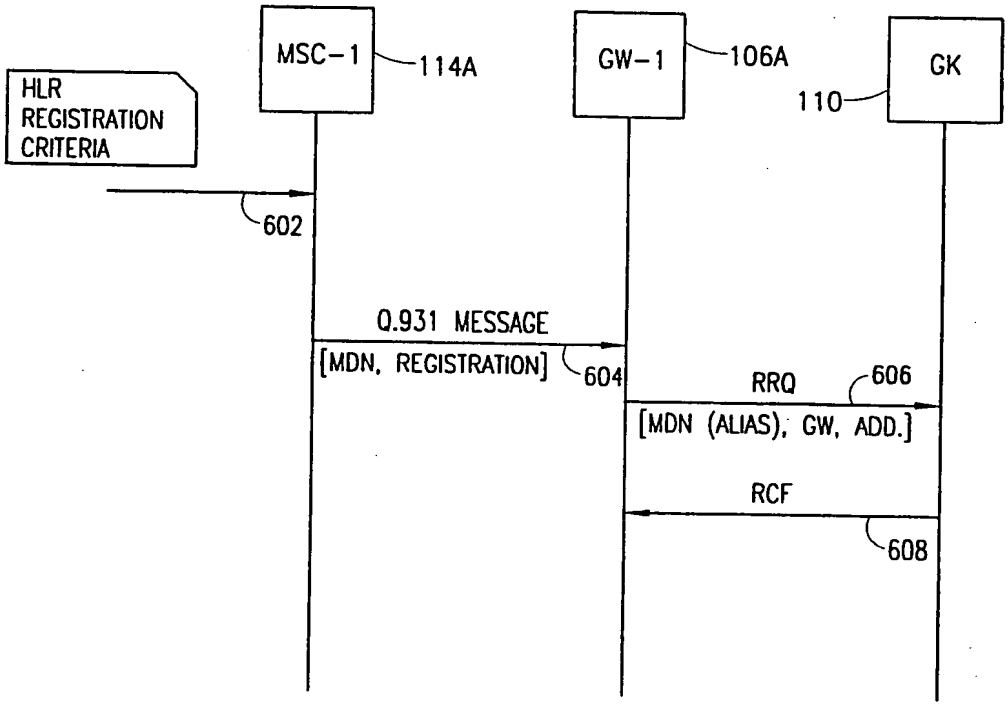

FIG. 6A

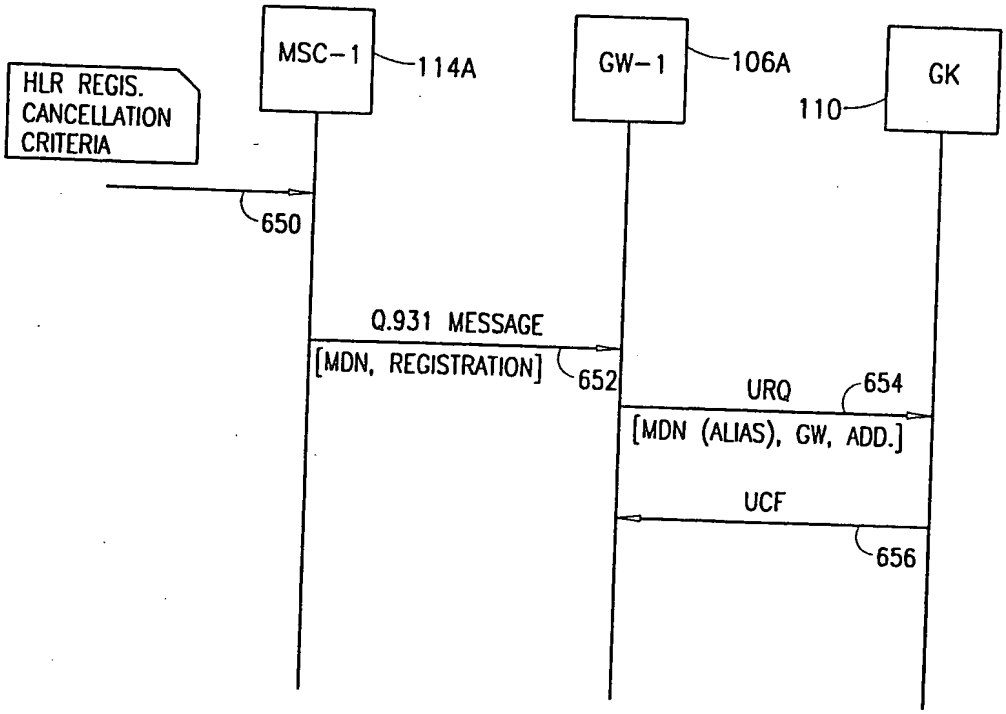

FIG. 6B

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(74) Agent: ERICSSON RADIO SYSTEMS AB; Patent Unit Radio Access, S-164 80 Stockholm (SE).

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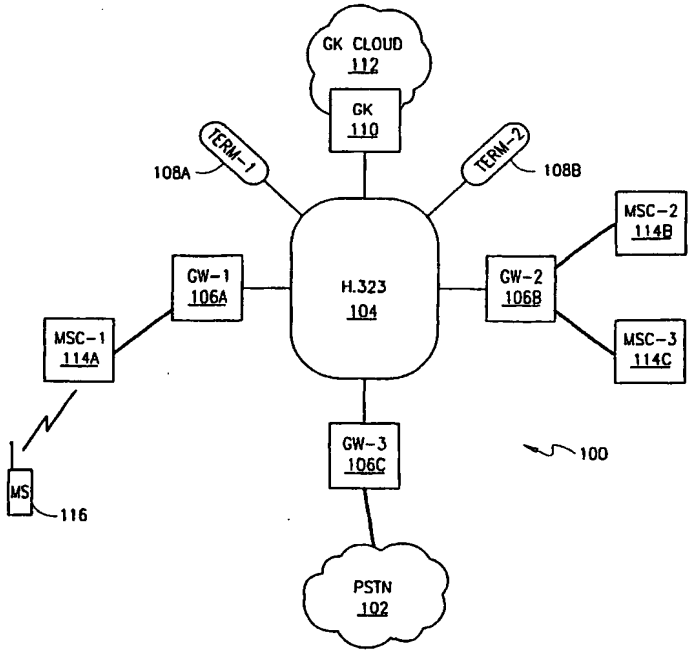
Published:
— *with international search report*

[Continued on next page]

(54) Title: SYSTEM AND METHOD FOR IMPROVED RESOURCE MANAGEMENT IN AN INTEGRATED TELECOMMUNICATIONS NETWORK HAVING A PACKET-SWITCHED NETWORK PORTION AND A CIRCUIT-SWITCHED NETWORK PORTION



(57) Abstract: A system and method for providing improved resource management, e.g., bandwidth re-allocation, in an integrated telecommunications network (100) having a packet-switched network portion (e.g., a Voice-over-Internet Protocol (VoIP) network portion) (104) and a cellular network portion (114). When a parametric variable associated with the number of registrations of mobile stations in a Mobile Switching Center (MSC) (114A) passes a threshold test (206), the MSC sends a message (306) to its gateway (106A), the message including a level change parameter. Responsive thereto, the gateway re-registers in a gatekeeper (110) that is provided for managing a zone in the VoIP network. The gateway includes in its registration request (308) the level change parameter received from the MSC. The gatekeeper uses the level change parameter as an input to its resource management function and re-allocates the resources available for the gateway.

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(88) Date of publication of the international search report:
13 December 2001

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International Application No
I../SE 00/02045

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04L12/66 H04Q11/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04L H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 99 52237 A (VERTICLE NETWORKS INC) 14 October 1999 (1999-10-14) page 17, line 11 - line 25 page 21, line 4 - line 9; claim 13	1-22
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-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 May 2001	29. 06. 2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Kristoffer Ogebjer

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Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
P../SE 00/02045

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 413 488 A (AMERICAN TELEPHONE & TELEGRAPH) 20 February 1991 (1991-02-20) abstract; claim 1 ---	1-22
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A	WO 99 14931 A (TRANSNEXUS LLC) 25 March 1999 (1999-03-25) page 10, line 22 -page 11, line 5 page 19, line 15 - line 20 ---	23-26
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P,X	WO 00 33518 A (ERICSSON TELEFON AB L M) 8 June 2000 (2000-06-08) page 9, line 14 -page 10, line 7 page 11, line 9 - line 18 ---	23-26
P,X	WO 00 33523 A (ERICSSON TELEFON AB L M) 8 June 2000 (2000-06-08) page 3, line 64 -page 5, line 15 ---	23-26
P,A	WO 99 67970 A (ERICSSON TELEFON AB L M) 29 December 1999 (1999-12-29) page 2, line 11 - line 21 -----	23-26

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Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

'ernational application No.
PCT/SE 00/02045

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. [X] As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [X] As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

see extra sheet

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

[X] No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-22

   The invention re-allocates resources, by a gatekeeper, to the gateway when resources needed.

2. Claims: 23-26

   The invention routes an in-coming call by a gatekeeper to a mobile station using a gateway's network address. The gateway sends a register request to the gatekeeper including MDN and a network address associated with the gateway.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/SE 00/02045

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